Беспроводной DMX512 приемник/передатчик

Общая информация

В данной статье я расскажу вам как создать передатчик и приемник DMX512 сигнала. Выложена принципиальная схема, схема платы, и вся разводка. Апаратная часть построена на микроконтролере avr ATMEGA 328 от компании Atmel. Приемник и передатчик могут передавать все 512 каналов управления. Без антенны базовая конфигурация работает до 100 метров в прямой видимости*(сможет работать до 1км при установке антенны)*

Элементы используемые в схеме

Сборка состоит из микроконтролера

- NRF24L01 два модуля.
- 12v Вход (5v и 3.3v регулятор напряжения)
- 2 x XLR вход и выход(папа и мама)
- 2 x Светодиода(для индикации)
- ATMEGA328p-pu микроконтроллер.
- 3 x 100ом резисторы.
- 1 x 10кОМ резистор.
- 3 x 10uF конденсаторы.
- переключатель каналов, джампер.
- 16mHZ кварц.

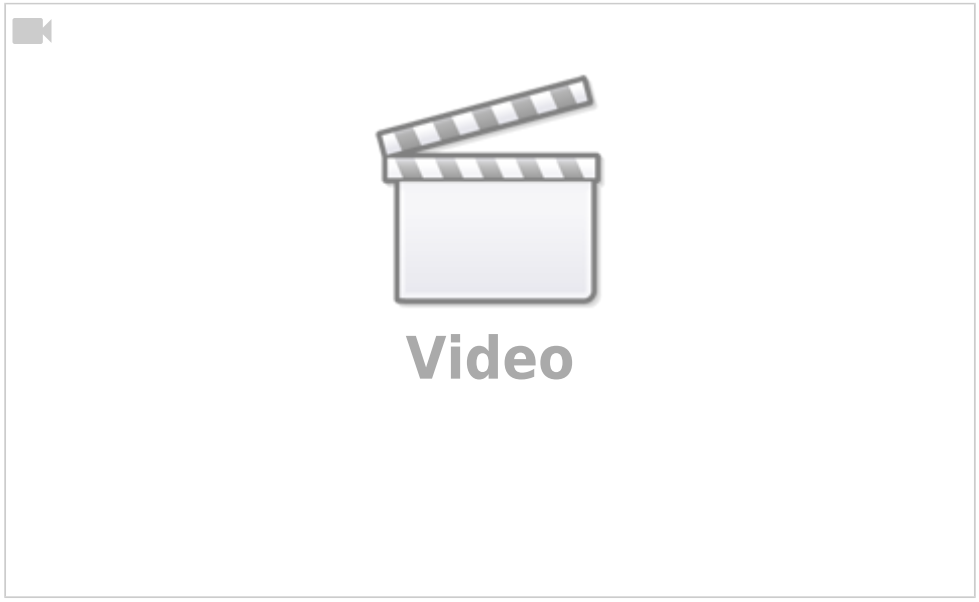
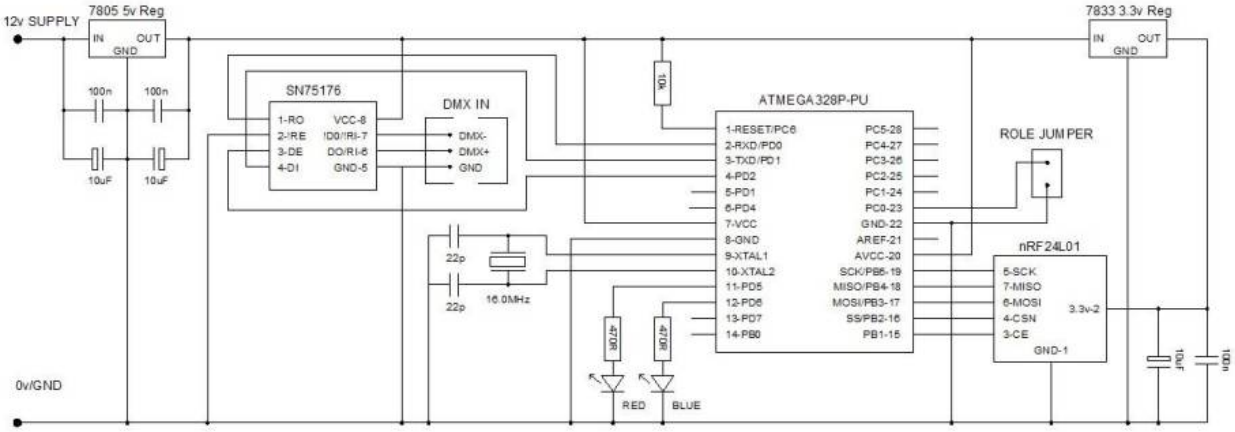


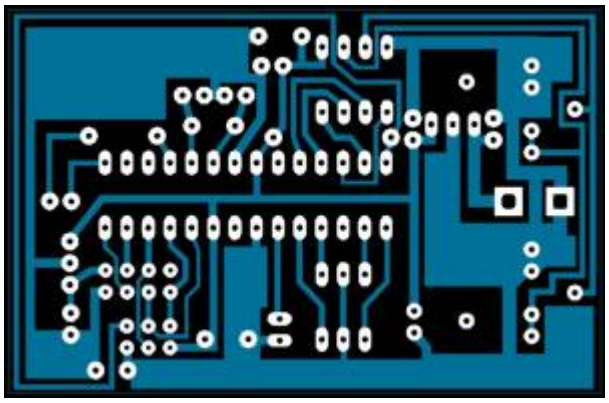
Схема подключения

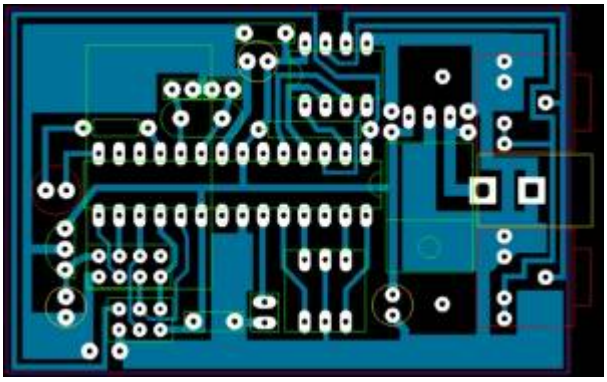


Беспроводной модуль в сборе

Для подключения радиомодуля использованы ножки аппаратного SPI микроконтроллера, поэтому разъемы подключения модуля и подключения программатор дублируют друг друга. Это сделано, чтобы удобней было прошивать микроконтроллер на отладночной платке, например, если использовать программатор который подает на схему 5 вольт, а для NRF24L01 это слишком большое напряжение. Чтобы перепрошить управляющий микроконтроллер, достаточно выдернуть трансивер с платы, перепрошить и всунуть его обратно - без лишней возни с перепайкой.

Готовая плата





Существуют ситуации, когда где DMX кабель невозможно протянуть, или использование его просто не практично. Этот проект реализует беспроводную передачу сигнала DMX в диапазоне 2,4 ГГц, используя платформу Arduino и популярного модуля приемопередатчика NRF24L01 + из нордического полупроводника.

Протокол передачи

Прием и передача по протоколу DMX осуществляется на контроллере ATmega с помощью библиотеки DMXSerial. Реализация использует прерывания и является хорошей базой для реализации второго протокола на одном чипе. 2,4 Радиомодуль подключен к плате Arduino или микроконтроллеру ATmega с помощью интерфейса SPI. Библиотека для использования чипа находится здесь https://github.com/gcopeland/RF24 . После инициализации библиотеки можно передавать и принимать данные, используя прилагаемые функции библиотеки. Библиотека передает все команды и данные микросхемы nRF24L01 + также будет обрабатывать все детали передачи в фоновом режиме.

Скетч для микроконтроллера

ВНИМАНИЕ: перед компиляцией и заливкой скетча в микроконтроллер, необходимо установить и добавить в компилятор библиотеки nRF24L01 и RF24

```
// FOR ATMEGA328 16mhz ONLY //
// connection information...
// http://arduino-info.wikispaces.com/Nrf24L01-2.4GHz-HowTo
// SN75176 configuration :
//   DMXrx NRFtx : pin 2 = 0v | pin 3 = 0v
```

```
//   NRFrx DMXtx : pin 2 = 0v | pin 3 = 5v
//   pin 6 = DMX+ | pin7 = DMX-
// Ensure 3.3v is used to supply NRF24L01 board !!
//
// the Nrf24L01 board can only transmit from channel 0 to 83 in the USA,
therefore we shall limit it to 0-80 in steps of 5

#include <EEPROM.h>
#include <SPI.h>
#include <nRF24L01.h> // library: https://github.com/maniacbug/RF24
#include <RF24.h>
#include <Wire.h>
#include <DMXSerial.h> // library:
http://www.mathertel.de/Arduino/DMXSerial.aspx //

#define MAX_DMX_CHANNELS 512 // full DMX
#define BYTES_PER_PACKET 16 // usable bytes per packet
#define PACKET_OVERHEAD 2 // group and time stamp
#define MAXPAYLOAD (BYTES_PER_PACKET+PACKET_OVERHEAD) // max payload size
for nrf24l01
#define MAXGROUPS (MAX_DMX_CHANNELS/BYTES_PER_PACKET) // 32 groups of 16
channels = 512 DMX channels

// 16way hex channel selector - hex switch mounted with zero at top (see PCB
layout)
#define HEX_0 A4
#define HEX_1 A1
#define HEX_2 A2
#define HEX_3 A5
// nRF24L01 control
#define nRF_CE 9 // Chip enable
#define nRF_CSN 10 // Chip select not
// LEDs
#define LED_BLUE 6 // BLUE PWM
#define LED_RED 5 // RED PWM
// sn76175 control
#define DMX_NOT_EN 2
#define DMX_MODE 3
// other
#define ROLE A0 // if low (jumper on) then RX otherwise TX

RF24 radio(nRF_CE,nRF_CSN);

unsigned long RXtimer, flashTimer, taskTimer, lastFlash, refreshTimer,
radioTimer, rePairTimer;
uint64_t RXTXaddress, pairingAddress = 0xF0F0F0F0F0LL;
uint16_t rfQuality;
uint8_t payload[MAXPAYLOAD], shadow_DMX[MAX_DMX_CHANNELS];
uint8_t timeStamp, lastStamp, bestChannel;
uint8_t HEXchannel, _HEXchannel, RXTXchannel, pairingChannel = 80;
```

```
boolean role, _role, group_send;

void setup(void)
{
  // set DMX/rs485 interface
  pinMode(DMX_NOT_EN, OUTPUT);
  digitalWrite(DMX_NOT_EN, LOW);
  pinMode(DMX_MODE, OUTPUT);
  // set bicolour LED
  pinMode(LED_BLUE, OUTPUT);
  digitalWrite(LED_BLUE, LOW);
  pinMode(LED_RED, OUTPUT);
  digitalWrite(LED_RED, LOW);
  // set up ROLE switch
  pinMode(ROLE, INPUT_PULLUP);
  // set up HEX channel select switch
  pinMode(HEX_0, INPUT_PULLUP);
  pinMode(HEX_1, INPUT_PULLUP);
  pinMode(HEX_2, INPUT_PULLUP);
  pinMode(HEX_3, INPUT_PULLUP);
  if ( digitalRead(ROLE) ) { // jumper off : transmitter : initialise & read
EEPROM
    init_EEPROM();
  }
  radio.begin();

// test nRF board, if it doesnt reply then flash LED indefinately, or until
it does reply
  while (!radio.isPVariant() ) { // check if board connected
    if (digitalRead(ROLE)) { blue(); delay(500); off(); delay(500); }  //
Wireless TX : if no rf comms then flash BLUE 50%
    else { red(); delay(500); off(); delay(500); }  // Wireless RX : if no
rf comms then flash RED 50%
  }

  // generic radio stuff
  radio.setAutoAck(false);
  radio.setPayloadSize(MAXPAYLOAD);
  radio.setPALevel(RF24_PA_HIGH);
  radio.setDataRate(RF24_250KBPS);
  radio.setRetries(0,0);
  //radio.setDataRate(RF24_1MBPS);
  //radio.setDataRate(RF24_2MBPS);

  HEXchannel = HEXread();

// if this is a transmitter, do a channel scan, transmit network RXTXaddress
and clean RXTXchannel during rePair (every 2 secs)
// only send clean channel data if channel selector is set to zero (send
0xFF if channel other than zero : manualPair)
  if ( digitalRead(ROLE) ) { // jumper off : transmitter
```

```
    bestChannelScan(); // only do channel scan if this is a transmitter -
bestChannel is required for manualPair and autoPair modes
    if (HEXchannel) { //
      bestChannelDisplay(); // if HEX switch not zero display best channel
number
    }
  }
// if this is a receiver, go into pairing mode and wait (indefinately) for
pairing & channel data
// only use received (clean) channel data if channel selector is set to zero
  else  {
    receivePairingAddress();
  }
  rePairTimer = flashTimer = taskTimer = millis(); // TXtimer =
  DMXSerial.maxChannel(MAX_DMX_CHANNELS);
  rfQuality = 0;
  // read and initialise HEX switch and Role jumper
  readPins(true);
} // end of init


void loop(void) {
// once per second, test for changes in HEX Switch and Role jumper (rx/tx)
  if (millis() - taskTimer > 1000) {
    taskTimer = millis();
    readPins(false);
  }

// JUMPER OFF : DMX --> WIRELESS Tx
// LED Wireless TX : Solid BLUE, broken with very short flash of RED only if
DMX data is being received.
  if (digitalRead(ROLE)) { // if a wireless transmitter
  // SEND OUT BURSTS OF RADIO DATA EVERY 30ms....
    for (uint8_t group = 0; group < MAXGROUPS; group++) { // scan through
the groups of DMX data, 30 bytes at a time
      uint16_t group_ptr = group*BYTES_PER_PACKET; //30; // create group
pointer for array
      if (millis() - refreshTimer > 1000) { // allow ALL radio data (full
DMX array) to be send once per second, regardless of changes
        group_send = true; // force ALL send
        refreshTimer = millis();
      } //if refresh timer
      else {
        group_send = false; // preset flag to false, only set it if there
has been a data change since last time
      } // not refresh timer
      for (uint8_t chan = 1; chan < BYTES_PER_PACKET+1; chan++) {
        if ( DMXSerial.read(group_ptr+chan-1) !=
shadow_DMX[group_ptr+chan-1] ) { // compare test : current DMX against old
DMX
```

```
          shadow_DMX[group_ptr+chan-1] = DMXSerial.read(group_ptr+chan-1);
// if changed, update shadow array of DMX data and payload
          group_send = true; // set flag so that THIS group packet gets sent
        } // if data compare
        payload[chan+1] = DMXSerial.read(group_ptr+chan-1); // ensure ALL
up-to-date data gets through on this packet
      } // for chan
      if (group_send) { // only send the data that has changed, any data
change in a group will result in whole group send
        payload[0] = group; // set first byte to point to group number
(groups of 30 bytes)
        payload[1] = timeStamp++; // second byte helps us monitor
consistency of reception at receiver with a continuous frame counter
        radio.write( payload, sizeof(payload) ); // dump payload to radio
      } // if group_send
    } // for group
    if ( (DMXSerial.noDataSince() < 2000) && (millis() > 1000) ) { // if DMX
has been received within the last 2 seconds make LED flash
      if (!(millis() & 0b1111000000)) {
        red();
      }
      else { // SIMPLE DMX FLASHER
        digitalWrite(LED_RED,0);
        analogWrite(LED_BLUE,5); // low level Blue
      }
    }
    else { // no DMX data present, no flash
      digitalWrite(LED_RED,0);
      analogWrite(LED_BLUE,5);
    }
    // trigger rePair information send, just once every 2 seconds
    if (millis() - rePairTimer > 2000) {
      rePairTimer = millis();
      rePairTX(); // single burst of pairing information on pairing channel
using pairing network address
    }
  } // if role

// JUMPER ON
// WIRELESS --> DMX
// LED Wireless RX : Solid RED, broken with flash of BLUE if wireless is
being received (channel match)
//                   the gaps between the BLUE flashes are dependant on
consistency of consecutive packets, relating to timeStamp
  else {
    if (millis() - RXtimer > 20000) { // after 20 seconds without receving
any radio data, try and rePair
      receivePairingAddress();
    }
    else if (millis() - RXtimer > 2000) { // after 2 seconds of no radio
data, stop blinking
```

```
      rfQuality = 0;
    }
    if ( radio.available() ) {
      if (!rfQuality) {
        rfQuality = 50; // just to show that channel and address are locked
on !
      }
      RXtimer = millis();
      radio.read( payload, sizeof(payload) ); // get data packet from radio
      if ( payload[1] == (lastStamp+1) ) { // check for continuous
timestamps, increase quality indicator if good
        if (rfQuality < 255) { rfQuality++; }
      }
      else { // if incontinuous, reduce quality indicator/LED brightness
       if (rfQuality > 50) { rfQuality--; }
      }
      lastStamp = payload[1]; // reset last time stamp to current for
checking next time
      for (uint8_t i = 0; i <BYTES_PER_PACKET; i++) {
        DMXSerial.write((BYTES_PER_PACKET*payload[0])+i, payload[i+2]); //
spill radio data into dmx data array
      }
    } // if radio avail
    lastFlash = millis() - flashTimer;
    if (lastFlash < 64) {
      digitalWrite(LED_RED,0);
      analogWrite(LED_BLUE,rfQuality); // show rfQuality as brightness of
BLUE LED
    }
    else if (lastFlash >= 64) {
      digitalWrite(LED_BLUE,0);
      analogWrite(LED_RED,5); // switch back to RED at low level
    }
    if (lastFlash > 1024) {
      flashTimer = millis(); // reset timer after 1 second(ish)
    }
  } // else
} // loop

// read HEX switch and Role jumper, if there has been a change in settings
then an update can be made
void readPins(boolean initialise) {
  _HEXchannel = HEXread(); // get temp HEXchannel
  _role = digitalRead(ROLE); // get temporary Role
  if (_role != role || initialise) { // has the ROLE changed ?? - initialise
will override any change in settings
    role = _role;
    if (role) { // JUMPER OFF : this is a wireless transmitter
      digitalWrite(DMX_MODE,LOW); // enable rs485 for input
      DMXSerial.init(DMXReceiver); // enable DMX to receive
```

```
      radio.openWritingPipe(RXTXaddress); // set network address
      radio.stopListening(); // start talking !
      digitalWrite(LED_RED,0);
      analogWrite(LED_BLUE,5); // low level BLUE to start...
    }
    else { // JUMPER ON : this is a wireless receiver
      digitalWrite(DMX_MODE,HIGH); // enable rs485 for output
      DMXSerial.init(DMXController); // enable DMX for output only
      radio.openReadingPipe(1,RXTXaddress); // set network address
      radio.startListening(); // start listening for data
      digitalWrite(LED_BLUE,0);
      analogWrite(LED_RED,5); // low level RED to start...
    }
  }
  if (_HEXchannel != HEXchannel || initialise) { // has the CHANNEL changed
? - 'initialise' overrides any change in settings
    HEXchannel = _HEXchannel;
    rfQuality = 0; // reset this so that led stops flashing
    if (!role) {
      radio.stopListening(); // if this is a receiver...
    }
    if (HEXchannel) {
      RXTXchannel = HEXchannel*5; // create real channel number from HEX
read
    }
    radio.setChannel(RXTXchannel); // set the channel
    if (!role) {
      radio.startListening(); // if this is a receiver...
    }
  }
}

void red(void) {
  digitalWrite(LED_BLUE,0);
  digitalWrite(LED_RED,1);
}
void blue(void) {
  digitalWrite(LED_BLUE,1);
  digitalWrite(LED_RED,0);
}
void off(void) {
  digitalWrite(LED_BLUE,0);
  digitalWrite(LED_RED,0);
}

// manualPair & autoPair information
// selecting HEXchannel 0 instigates "autoPair" mode on transmitter and
receivers, therefore channel zero cannot be used in manualPair mode
// The transmitter and receivers MUST be set to either ALL autoPair(0) or
ALL manualPair(1-15) to work correctly
// manualPair mode can only select RXTXchannels 5 to 75 (via hex switch
```

```
positions 1-15)
// manualPair & autoPair (on the Transmitter) has a 'bestChannelScan' on
power-up
// autoPair : The best(quietest)channel will be transmitted with the network
address on pairing
// manualPair : The best(quietest)channel is shown by number of blinks
(shown as 3 groups of blinks) (bestChannelDisplay)
// The RXTXchannel number is 5 times that indicated - example 5 blinks =
channel 60
// In manualPair, the transmitter and all receivers must be manually set to
that channel via the hex switch

// Transmitter : every 2 seconds, the transmitter sends its network
address/pipe number as data on channel 80, using a a pairing address/pipe
// Receivers : on power up, receiver(s) are in pairing mode, receiver goes
to channel 80 and listens on the pairing address/pipe for the network
address and channel number to go to
//             receivers change to the network channel and wait for
DMX/Radio data to arrive. If any receiver loses pairing, after 20 seconds it
will start to repair again.

void bestChannelScan(void) {
 uint8_t carriers[16], reps, i, best=200;
 for (reps=0; reps<200; reps++)  { // scan all channels 200 times
   for (i=1; i<16; i++) {
      radio.setChannel(i*5); // scan from channel 5 to 75 in steps of 5
      radio.startListening();
      delayMicroseconds(128);
      radio.stopListening();
      if ( radio.testCarrier() )
        ++carriers[i]; // if there is any signal present, increase value in
array
    } // i
  } // reps
  for (i=15; i>0; i--) { //  find quietest channel, starting from highest
channel
    if (carriers[i] < best) {
      best = carriers[i]; // save quietest value
      RXTXchannel = i*5; //and save corresponding channel number
    }
  }
}

// BestChannel will only display if transmitter is not on HEX SWITCH 0
void bestChannelDisplay(void) {
  uint8_t i, x;
  for (x=0; x<3; x++) {
    for (i=0; i<RXTXchannel/5; i++) {
      blue();
      delay(25);
```

```
      off();
      delay(375);
    }
  delay(1000);
  }
}
// read the value of the Hex Switch
uint8_t HEXread(void) {
    return (!digitalRead(HEX_0)) | (!digitalRead(HEX_1) << 1) |
(!digitalRead(HEX_2) << 2) | (!digitalRead(HEX_3) << 3);
}

// reguarily, the transmitter sends out a short burst of the config data on
the pairing channel and using the pairing address
void rePairTX(void) {
  radio.openWritingPipe(pairingAddress);
  radio.setChannel(pairingChannel);
  radio.stopListening();
  payload[0] = (uint8_t) (RXTXaddress);
  payload[1] = (uint8_t) (RXTXaddress >> 8);
  payload[2] = (uint8_t) (RXTXaddress >> 16);
  payload[3] = (uint8_t) (RXTXaddress >> 24);
  payload[4] = (uint8_t) (RXTXaddress >> 32);
  if (HEXread()) { payload[5] = 0xFF; }
  else { payload[5] = RXTXchannel; }
  radio.write( payload, sizeof(payload) ); // dump pairing data to radio
  radio.openWritingPipe(RXTXaddress);
  radio.setChannel(RXTXchannel);
  radio.stopListening();
}

void receivePairingAddress(void) {
  uint8_t p, q;
  radio.stopListening();
  radio.openReadingPipe(1,pairingAddress);
  radio.setChannel(pairingChannel);
  radio.startListening();
  digitalWrite(LED_BLUE,LOW);
  while ( !radio.available() ) {
    analogWrite(LED_RED,p++); delay(2); // slowly pulse RED LED while
awaiting pairing connection
  }
  radio.read( payload, sizeof(payload) ); // get data packet from radio if
available
  RXTXaddress = (uint64_t)(payload[0]) | (uint64_t)(payload[1] << 8) |
(uint64_t)(payload[2] << 16);
  RXTXaddress |= (uint64_t)(payload[3] << 24) | (uint64_t)(payload[4] <<
32); // get RXTX address from payload
  if ( payload[5] == 0xFF ) {
    RXTXchannel = HEXread()*5; // use channel from hex switch
  }
```

```
  else {
    RXTXchannel = payload[5]; // use best channel from scan
  }
  radio.stopListening();
  radio.openReadingPipe(1,RXTXaddress);
  radio.setChannel(RXTXchannel);
  radio.startListening();
  RXtimer = millis();
}

void init_EEPROM(void) {
// do this only if a transmitter
// if the EEPROM hasnt already been set (all bytes at 0xFF) then set an
address using 2 random numbers to make up unique 40bit address
// the address will be used in pairing. Once it has been set the first time
it wont need to be set again
  if ( digitalRead(ROLE) ) { // jumper off : transmitter
    if ( (EEPROM.read(0) == 0xff) && (EEPROM.read(1) == 0xff) ) {// check
for uninitialised/used eeprom memory
      randomSeed(analogRead(A3)); // seed from unused floating analog port
      EEPROM.write(0,random(255)); // unique lowest byte only
      EEPROM.write(1,random(255)); // initialise 40 bit address number into
eeprom, this makes up bytes 1-4 in address
    }
    RXTXaddress = (uint64_t) (EEPROM.read(0)) | (uint64_t)(EEPROM.read(1) <<
8) | (uint64_t)(EEPROM.read(1) << 16);
    RXTXaddress |= (uint64_t)(EEPROM.read(1) << 24) |
(uint64_t)(EEPROM.read(1) << 32); // reconstruct RXTXaddress from eeprom,
byte 0 is unique, bytes 1-4 are the same
  }
}
```

#define ROLE A0 - Эта строка отвечает за прием и ли передачу. Если нужен приемник то A0, передатчик A1

Следите за правильным напряжением, радиомодули очень чувствительны, напряжение должно быть в пределах 3.3v